ORIE 5380, CS 5727: Optimization Methods
Homework Assignment 4
Due October 18, 12:00 pm

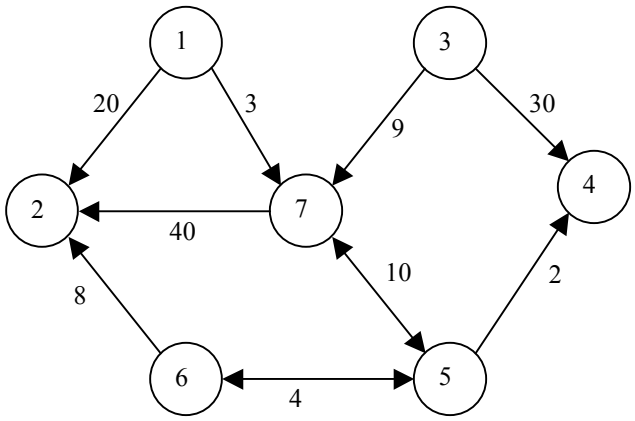
Please submit a single PDF document formatted to print and show all your work clearly. Feel free to scan and submit handwritten work. Do not spend too much time on wordprocessing your answers.

Question 1

The figure below represents an oil pipeline network. The different nodes represent pumping and/or receiving stations. The lengths in miles of the different segments of the network are shown on the respective arcs. The bi-directional segments allow flows in both directions. The supplies at stations 1 and 3 are respectively 50 and 60 barrels per day. The demands at the stations 2 and 4 are respectively 90 and 20 barrels per day. Assume that the transportation cost is proportional to the distance and we are interested in minimizing the total transportation cost.

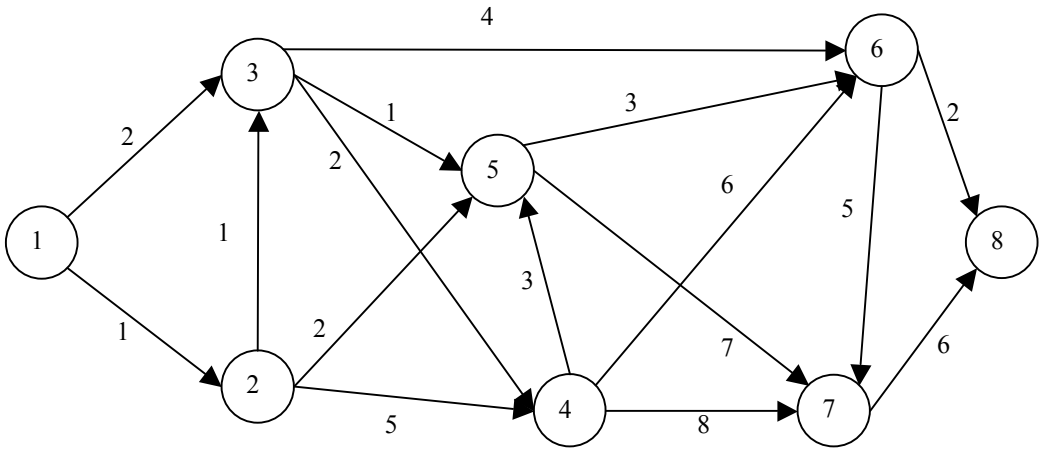
a) Formulate the problem as a min-cost network flow problem (i.e. write the problem that consists of an objective function and constraints).

b) Find the minimum-cost transportation schedule by using optimization software. You can either use Excel or use Gurobi as a standalone solver by reading the model from a text file you manually create. Turn in either the formulas in your Excel spreadsheet or the text file that you read through Gurobi.



(*There are three problems in this homework.*)

Question 2
The network below represents the distances in miles between various cities.



a) Formulate a linear optimization problem for finding the shortest path from city 1 to city 8 (i.e. write the problem that consists of an objective function and constraints).

b) Using optimization software, find the shortest paths between the following pairs of cities: (from city 1 to city 8), (from city1 to city 6), (from city 4 to city 8) and (from city 2 to city 6). You can either use Excel or use Gurobi as a standalone solver by reading the model from a text file you manually create. Turn in either the formulas in your Excel spreadsheet or the text file that you read through Gurobi.

Question 3

(This problem is from Hillier and Lieberman)

9.6-5. The Makonsel Company is a fully integrated company that both produces goods and sells them at its retail outlets. After production, the goods are stored in the company's two warehouses until needed by the retail outlets. Trucks are used to transport the goods from the two plants to the warehouses, and then from the warehouses to the three retail outlets.

Using units of full truckloads, the following table shows each plant's monthly output, its shipping cost per truckload sent to each warehouse, and the maximum amount that it can ship per month to each warehouse.

To / From	Unit Shipping Cost		Shipping Capacity		Output
	Warehouse 1	Warehouse 2	Warehouse 1	Warehouse 2	
Plant 1	$1175	$1580	375	450	600
Plant 2	$1430	$1700	525	600	900

For each retail outlet (RO), the next table shows its monthly demand, its shipping cost per truckload from each warehouse, and the maximum amount that can be shipped per month from each warehouse.

To / From	Unit Shipping Cost			Shipping Capacity		
	RO1	RO2	RO3	RO1	RO2	RO3
Warehouse 1	$1370	$1505	$1490	300	450	300
Warehouse 2	$1190	$1210	$1240	375	450	225
Demand	450	600	450	450	600	450

Management now wants to determine a distribution plan (number of truckloads shipped per month from each plant to each warehouse and from each warehouse to each retail outlet) that will minimize the total shipping cost.

a) Draw a network that depicts the company's distribution network. Identify the supply and demand nodes, and the nodes that are neither supply nor demand nodes.

b) Formulate the problem of finding the minimum-cost shipment schedule as a min-cost network flow problem (with upper bounds on how much we can ship over each arc).

c) Find the minimum-cost transportation schedule by using optimization software. You can either use Excel or use Gurobi as a standalone solver by reading the model from a

text file you manually create. Turn in either the formulas in your Excel spreadsheet or the text file that you read through Gurobi.